

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SIXTH SEMESTER EXAMINATION, MAY 2018

THIRD YEAR [BATCH 2015-18]

Date : 04/05/2018

PHYSICS (Honours)

Time : 11 am – 1 pm

Paper : VII [Gr-A]

Full Marks : 50

Answer any five questions of the following :

[5×10]

1. a) Explain the origin of the volume energy, surface energy and Coulomb energy term in the B–W mass formula and compare their contributions to the binding energy of the nucleus. [3]
b) Using liquid drop model explain the increase in binding fraction curve for light nuclei and the slow decrease in the curve after a broad maximum. [3]
c) Find the expression for constant a_c determining the Coulomb energy assuming nucleus to be a uniform charged sphere. [4]
2. a) Explain the variation of total linear absorption coefficient with energy of γ -ray. [3]
b) Compare among the different processes by which γ -rays interact with matter.
If the maximum energy of the recoil electrons be 1MeV in the compton scattering of a certain γ -ray, what is the energy of the photon? [3+2]
c) Can pair production takes place in free space? Explain. [2]
3. a) What is straggling of range of α -particles? What are the factors causing straggling? [2+2]
b) Explain the existence of continuous spectrum of β -particles. What is end-point energy? [2+1]
c) A beam of mono-energetic γ -ray is incident on an aluminium sheet of thickness 10 cm. The sheet reduces the intensity of the beam to 21% of the original. Calculate the linear and mass absorption coefficients. Given the density of aluminium to be 2700 kg/m^3 . [3]
4. a) Polonium-212 emits an α -particle with kinetic energy 10.54 MeV . Determine the α -disintegration energy. [3]
b) What is cross-section of nuclear reaction. Give its geometrical significance. [4]
c) Using the liquid drop model find the value of r_0 , nuclear radius parameter, for the β^+ -decay of ${}^{13}_7\text{N}$. The maximum energy of a β^+ particle is found to be 1.19 MeV . [3]
5. a) Explain how the thermo-nuclear reactions are possible at the sun-temperature ($20 \times 10^6 \text{ K}$) although for p-p interaction the kinetic energy of the order of 0.1 MeV ($1200 \times 10^6 \text{ K}$) is required. [2]
b) Give example of β^+ -decay, β^- -decay and electron capture with energy decay schemes. [3]
c) Explain the construction and working of a linear accelerator. Calculate the final energy of the ion for a linear accelerator. [4+1]
6. a) Describe proton-proton chain reaction important at low temperature. [1]
b) What are transuranic elements. [2]
c) Explain how Ghoshal experiment establishes compound nucleus hypothesis of Bohr. [5]
d) A Betatron of 100 MeV energy has a stable radius of 0.84 m . Calculate the frequency of the applied electric field if average energy gain per turn 420 eV . [2]

7. a) Which of the following interactions are allowed or disallowed? Explain with reasons. [5]
- $\pi^- + p \rightarrow K^+ + \pi^- + \Lambda^0$
 - $\pi^- + p \rightarrow K^- + \pi^+ + \Lambda^0$
 - $\pi^- + p \rightarrow \Sigma^+ + K^-$
 - $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$
 - $\pi^- \rightarrow \mu^- + \bar{\nu}_e$
- b) What is the Gell-Mann-Nishijima (G-M-N) relation? What should be the strangeness assignment of the following particles according to G-M-N relation?
- π^+
 - Λ^0
 - Σ^-
 - n
- [1+2]
- c) To what spatial resolution can we resolve the structure of an elementary particle by a 100GeV electron? [2]
8. a) Depict the weight diagrams of the {u d s} quarks and their antiparticles. Hence obtain the weight diagram of Mesons by combining the weight diagrams of quarks. Identify each meson in the diagram. [2+3]
- b) What do you mean by the intrinsic parity of an elementary particle? A spin zero particle A at rest decays into two spin zero particles. What should be the relation between the intrinsic parities between particle A and its daughters if parity conservation is assumed for the decay. [3]
- c) Give the quark composition of the following hadrons.
- π^+
 - n
 - Σ^+
 - K^-
- [2]

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